Habitat Technology Research at DLR

Abstract

For long duration space missions a closed-loop system which can re-use of materials is mandatory. Also on Earth there are harsh environments or overpopulated areas where a sustainable handling of given goods is indispensable. Addressing these challenges the German Aerospace Center (DLR) conducts research in various fields of habitat technology development, which will be illustrated within this paper. There are various complementary topics, such as coordination and funding of building blocks for Life Support and Energy Systems on behalf of the Federal Government, health and performance of astronauts, regenerative (e.g. bio-filter) and hybrid systems and plant and algae cultivation under closed environments, habitat research infrastructures and simulation as well as analogue testing experiments and spin-off potentials.

C.R.O.P. (KP-ME)

Demonstrator for Combined Regenerative Organic-food Production:

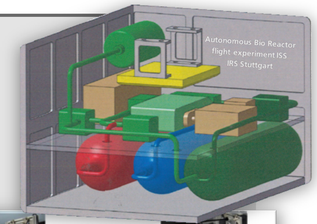
In the bio filter C.R.O.P. organic waste or urine dissolved in water is degenerated by bacteria producing a nitrate rich solution for plants cultivation.

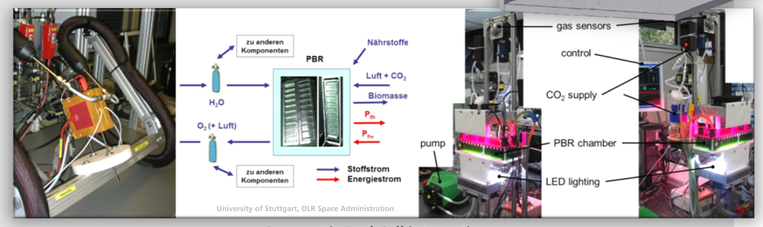
Crew (KP-ME)

:envihab with short-arm human centrifuge:

The concept of the medical research facility :envihab is to deal with complex problems of a life support system and the interaction between humans and the environment from a medical, biological and psychological point of view.

Hybrid Systems (RD-RM)

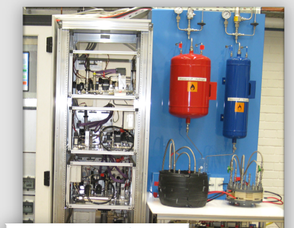


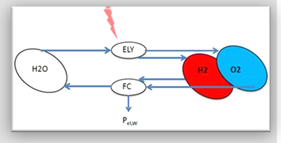


Synergetic Fuel Cell integration

Based on experiences from chem. phys. Life Support Systems developments a greater system cycle closure of Life Support Systems is gained by inclusion of biological processes to so called Hybrid Systems. Beside the additional O_2 generation food 'production' is gained. A first step: Fuel Cell integration and processing in a biological system consisting of an Algae Photo Bioreactor for O_2 generation. This synergetic and hybrid approach will be seen also as a spin-off able to solve several challenges on Earth.

Regenerative Fuel Cell (RD-RM)

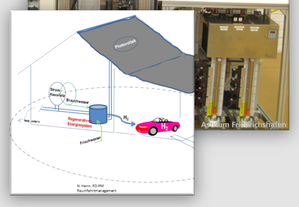




Regenerative system using Fuel Cell and Electrolyser

Derived from the great experience in Closed Loop Life Support Systems in Germany Regenerative (Reversible) Fuel Cell Systems (RFCS) have been developed. Alkaline RFC Systems uses the real gases H2 and O2 to generate and store energy like a secondary Battery. Beside others, advantages of these systems are increasing with its system 'charge and discharge' time. Thus we recommend RFCS for long time exploration mission.

As a spin-off RFCS are able e.g. to solve storage problems for renewable energy on Earth ('own home' solution).



Mobile Systems (KP-ME/HB-RY)

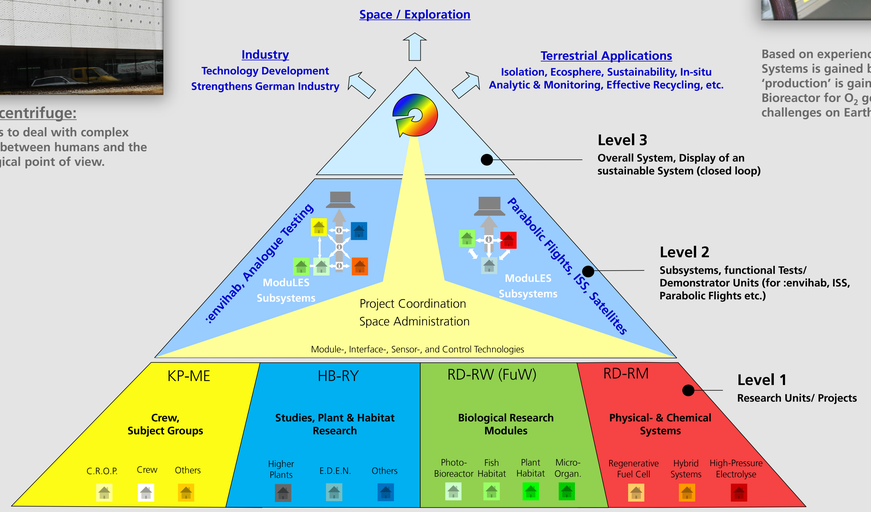
C.R.O.P.-Container:

For Earth application the combination of C.R.O.P and E.D.E.N technology in a standard container is studied for highly efficient food production.

E.D.E.N. LAB (HB-RY)

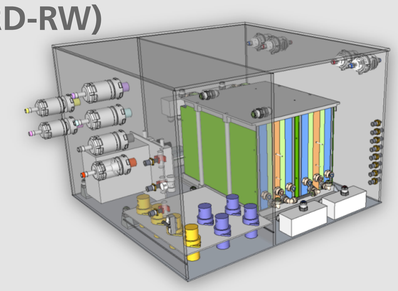
Evolution & Design of Environmentally-closed Nutrition-Sources:

Within the EDEN Initiative, new concepts for Greenhouse Modules as essential part within habitats are elaborated with a focus on the development of Controlled Environment Agriculture (CEA) Technologies, such as Aeroponic irrigation systems, high-performance LED systems, and CO_2 injection systems. The new EDEN Lab facilitates basic testing of these by using 12 plant grow chambers in total.



ModuLES hardware concept based on fully understood single habitat modules

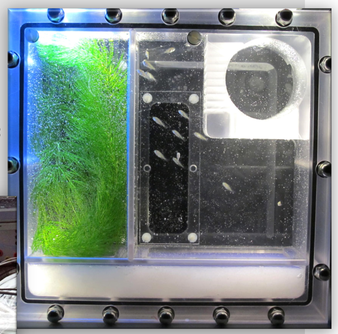
Plant Photo-Bioreactor (RD-RW)



ModuLES Photo-Bioreactor:

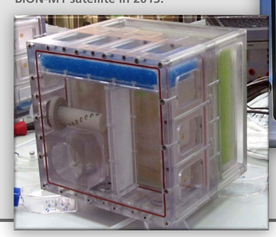
A microalgae-based, maximal efficient photo-bioreactor is being developed as key element of a modular regenerative life support and energy system (ModuLES) for production of oxygen and biomass as well as for biological research.

OMEGAHAB (RD-RW)



Oreochromis Mossambicus, Euglena Gracilis Aquatic HABitat:

A combined fish, microalgae and micro-organism habitat flown on the Russian BION-M1 satellite in 2013.



Analogue Testing (HB-RY)

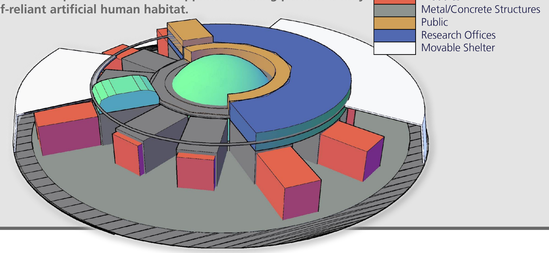
EuroMoonMarsB at MDRS and Greenhouse for polar stations:

In the desert of Utah and the Antarctic permafrost analogue behavior in terms of habitat design and life support technology was and will be tested.

Habitat Design Studies (HB-RY)

Facility of Laboratories for Sustainable Habitation:

The idea behind FLaSH is providing an infrastructure for testing and qualification of different innovative technologies for systems and modules for space and terrestrial application being parts of a fully self-reliant artificial human habitat.



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